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Abstract

Continuing education on dementia for healthcare providers has been shown to have positive effects on diagnostic confidence, knowledge, and care management. Technological approaches to educational delivery have been found to have comparable effects in terms of quality and efficacy. The purpose of the systematic review was to compose and present an evidence base for technology-delivered dementia education for healthcare providers. The review used PRISMA guidelines and Cochrane methods focusing on studies with a pre- and post-intervention evaluation. Technology-based delivery of dementia education was broadly defined as any technology-based medium delivered in real time or asynchronously. Ten studies were identified and analyzed using content analysis. The review revealed positive outcomes post-intervention, for dementia knowledge, readiness to change, receptiveness to training, communication skills, and self-efficacy. Studies were rated as medium to high quality on a scale for measurement of published data in research, and there was generally an unknown risk of bias due to a lack of a control group in most studies ($N = 7$). The findings revealed benefits of digitally-based, asynchronous continuing education for healthcare providers, which allow schedule flexibility and the ability to deliver remotely. Findings also revealed benefits of presentations using a variety of interactive educational materials via videos, voice recordings, textual medium and online discussion groups. Suggestions for intervention improvements include tailoring training for the specific needs and knowledge levels of healthcare practitioners and using validated scales to measure outcomes.

Keywords: dementia, education, technology, systematic review, Cochrane review

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Dementia exigency is a world predicament (WHO, 2012 Alzheimer Society of Canada, 2010) that has unique impact in rural settings (Canadian Academy of Health Sciences, 2019). Delivery of care and supports is contingent on timely diagnosis (Innes, Szmczynska, & Stark, 2014; Di Gregorio, Ferguson, & Wiersma, 2015), but inadequate dementia knowledge increases the potential for missed diagnoses (Coogle, Head, Parham, & Zeman, 2004). Once diagnosed, healthcare providers require knowledge of psychosocial and physical aspects of care (Coogle et al., 2004). A general lack of dementia training and education is reported by healthcare providers (Adler, Lawrence, Ounpraseuth, & Asghar-Ali, 2015; Barrett et al., 1997; Bryans, Keady, Turner, & Wilcock, 2003; Cary, 2009; Gandesha, 2012; Hallberg et al., 2016; Manthorpe, Iliffe, & Eden, 2003). Lack of dementia education impacts quality of services (Broughton et al., 2011), and hinders healthcare providers' abilities to provide care (Adler et al., 2015; Broughton et al., 2011; Cary, 2009; Gandesha, 2012; Hallberg et al., 2016). Dementia education can improve knowledge (Arnautovska, Roleda, Jackson, & Pachana, 2016; Boise et al., 1999; Broughton et al., 2011; Cody, Beck, Shue, & Pope, 2002; Eggenberger, Heimerl & Bennet, 2013; Elliot et al., 2012; Fossey et al., 2014; Gandesha, 2012; Harvey, Hovarth, Levine, & Volicer, 2006; Mitchell, Meader, & Pentzek, 2011; Spector, Revolta, & Orrell, 2016), clinical practice (Brody & Galvin, 2013; Spector, Orrell, Goyder, 2013; Zients at al., 2007; Galvin, Meuser, Boise, & Connell, 2011), increase confidence and skill (Boise et al., 1999; Broughton et al., 2011; Gandesha, 2012), encourage better coordinated care (Buhler et al., 2011), increase adherence to best practice guidelines (Galvin, Meuser, Boise, & Connell, 2011), improve attitudes (Manthorpe et al., 2003;

Sizemore, Vicioso, Lothrop, & Rubin, 1998), and reduce diagnostic uncertainty (Broughton et al., 2011; Harvey, et al., 2006; Rokstad et al., 2016).

Digital methods for education have the added advantage of remote, asynchronous delivery (Broughton et al., 2011; Harvey et al., 2006; Ruiz, Smith, van Zuilen, Williams, & Mintzer, 2006; Waldorff, Siersma, Nielsen, Steenstrup, & Bro, 2009) which offers particular benefits for rural and remote healthcare providers facing additional challenges such as a lack of access to specialized dementia services and continuing education (Kosteniuk et al., 2016). The present paper is a review of digital methods for dementia education. Importantly, the present review differs from earlier reviews (Alushi et al., 2015; Beeber et al., 2010; Boots et al., 2013; Brody et al., 2013; Eggenberger et al., 2013; Elliot et al., 2012; Fossey et al., 2014; Kuske et al., 2007; Raymond et al., 2014; Spector et al., 2013; Surr et al., 2017; Zients et al., 2007), in two ways: 1) focus on broad range of settings, healthcare professions, and types of digitally-based dementia education interventions; and 2) focus on studies with quantitative measures of a pre-intervention (baseline measure) and a post-intervention measure of change on outcomes. The current review addressed the following questions: 1) What learning technologies, online resources, and digital education tools on dementia are available? 2) At whom are the tools aimed (e.g., relevant characteristics of targeted healthcare providers)? 3) How many of the tools are for learning about dementia (e.g., causes, types and symptoms) versus dementia management or other purposes? 4) How are the digital education tools evaluated? 5) What are the measured, intended or unintended outcomes? Finally, this review also serves to establish a summary of existing digitally-based modes of dementia education, which can be used to design future digitally-delivered, asynchronous modes of dementia education for healthcare providers.

Method

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations (Moher, Liberati, Tetzlaf, & Altman, 2009), and Cochrane guidelines for systematic reviews and meta-synthesis (Moseley, Elkins, Herbert, Maher, & Sherrington 2009; Jørgensen, Hilden, & Gøtzsche, 2006) were employed. Studies were identified by searching electronic databases and reviewing the citations of articles selected for inclusion in the review (Figure 1) using Covidence, an online systematic review management software (Veritas Health Innovation, 2017). The search strategy process followed the Cochrane guidelines (Moseley, Elkins, Herbert, Maher, & Sherrington 2009) and the list of databases included PsychINFO, MEDLINE, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Sociological Abstract, SocINDEX, AgeLine, Anthropology plus, and Embase.

Two reviewers independently screened and made decisions for inclusion/exclusion, reasons for exclusion were recorded in a PRISMA diagram (see Table 1 and Table 2). Disagreement regarding inclusion was resolved via verbal deliberation, with a third individual available to arbitrate. Data extraction was performed in duplicate by the same two reviewers, with an adapted and customized data extraction form adapted from the Cochrane Collaboration (Higgins & Green, 2011). A meta-analysis was not possible due to the heterogeneity in outcomes, and lack of a control group in many of the studies. The results of the studies were qualitatively examined using content analysis to formulate categories or over-arching themes and to derive answers to the five research questions listed above.

Inclusion Criteria

Studies included in the review were published in English, and included at least one technology or digital tool that was used to convey dementia education targeted to healthcare professionals such as physicians, nurses, care workers, care aides, or personal support workers.

The digital tools included e-learning and other electronic media, via computer networks, teleconferencing networks or telephones. Included interventions had a measure of pre- and post-outcome findings and offered structured education defined as the delivery of predetermined dementia information.

Exclusion Criteria

Excluded studies were other systematic reviews, studies lacking an evaluative component, studies that used a satisfaction measure as the sole measure of the intervention effect, studies lacking structured education, studies lacking technology, studies targeting types of recipients other than healthcare professionals, studies lacking an educational dementia component, and studies where the educational component contained dementia in addition to other medical education, but where findings included a compounded analysis (e.g., the effect of the intervention on dementia knowledge could not be separated from the overall effects).

Risk of Bias and Study Quality

The risk of bias was assessed in duplicate by two reviewers using a set of criteria adapted from Cochrane methods for risk of bias evaluations (Higgins & Green, 2011). The risk of bias was rated independently by each reviewer for each study as *low*, *medium*, or *high* risk, and deliberated to achieve 100% agreement. The included studies were also subject to a quality review, which was performed by adapting checklists from the Critical Appraisal Skills Programme (CASP, 2014). One set of criteria was developed for evaluating studies of randomized controlled trials and one set was developed for studies with a single group evaluated pre- and post-intervention (see Tables 1 and 2).

The range of possible quality CASP scores for studies using non-randomized controlled trials (non-RCT studies) ranged from 0 to 18, where low quality studies ranged from 1 to 6,

medium quality studies ranged from 7 to 12, and high-quality studies ranged from 13 to 18. The range of possible quality CASP scores for randomized controlled studies (RCT studies), utilizing a single group who received the intervention, ranged from 0 to 21, where low quality studies ranged from 1 to 7, medium quality studies ranged from 7 to 15, and high-quality studies ranged from 16 to 21. The quality criteria were not used to determine study exclusion, but rather to provide a description of study quality. Studies which were deemed 'high quality' met the majority of the quality criteria. Studies which were deemed in the 'medium quality' range met an acceptable level of quality, and studies which were deemed in the 'low quality' range did not meet a sufficient number of quality criteria. The evaluation of study quality was performed independently by two reviewers with a third individual available to arbitrate.

Results

Ten studies were included in the review (see Table 3). Three studies were a randomized controlled trial (RCT) (Broughton et al., 2011; Downs et al., 2006; Rosen et al., 2002), and one study included a case-controlled study (Luconi et al., 2008). Of these ten studies, five included an education program derived from a theoretical model (Chao et al., 2016; Hobday et al., 2017; Irvine et al., 2012; Luconi et al., 2011; Pleasant et al., 2017). Theoretical models included learning models such as the Adult Learning Theory (Knowles, 1996), the Four-Stage Theory of Physician's Learning (Slotnick, 2001), and the Clinical Reasoning Model (Barrows & Feltovich, 1987). Other models were derived from larger theories in psychology, such as the Social Cognitive Learning Theory (Bandura, 1977) and the Expanded Theory of Reasoned Action (Fishbein & Ajzen, 1975). The remaining studies employed concepts derived from the *CARES*^{TM} Dementia-Friendly Hospital Learning Principles (Merkt, Weigand, Heier, & Schwan, 2011) and *CARES*^{TM} Dementia Basics Program principles (Hobday, Savik, Smith, & Gaugler, 2010). From

a total number of participants (N = 760) study-based sample sizes ranged from n = 8 to n = 113, of which 38% to 100% were female. Study attrition ranged from 1 to 11 participants, but four studies (Banks et al., 2014; Hobday et al., 2017; Luconi et al., 2008; Ruiz et al., 2006) did not report their attrition rates. The intervention duration ranged from a single 2-hour long session to a 12-month period with asynchronous completion of computer modules. Half of studies were conducted in United States (5 studies; see Table 4) (Hobday et al., 2017; Irvine et al., 2012; Rosen et al., 2002; Ruiz et al., 2006; Pleasant et al., 2017). The setting of interventions included long-term care/nursing homes (4 studies) (Chao et al., 2016; Broughton et al., 2011; Irvine et al., 2012; Rosen et al., 2002), secondary education or professional settings (2 studies) (Ruiz et al., 2006; Luconi et al., 2008), general practices/hospitals (3 studies) (Banks et al., 2014; Downs et al., 2006; Hobday et al., 2017; Pleasant et al., 2017; see Table 4). The geographic location of studies was largely unreported and unknown (in 9 studies), with only one study reporting a rural location (Luconi et al., 2008).

Risk of Bias

Risk of bias ratings for most studies was unknown due to the study design (see Table 5; e.g., single treatment group without controls or random allocation). For RCT studies (3 studies) (Broughton et al., 2011; Downs et al., 2006; Rosen et al., 2002), random allocation was presumed, but not always clearly reported. Only one RCT reported how the random allocation was performed (Downs et al., 2006). Concealment of allocation, blinding of participants, and blinding of assessment outcomes procedures were not always possible given the methods used by the majority of the included studies (either absence or presence of dementia education: 7 studies) (Banks et al., 2014; Chao et al., 2016; Hobday et al., 2017; Luconi et al., 2008; Irvine et al., 2012; Pleasant et al., 2017; Ruiz et al., 2006). In terms of data reporting five studies reported

only significant outcomes (Banks et al., 2014; Chao et al., 2016; Downs et al., 2006; Pleasant et al., 2017; Ruiz et al., 2006), and half of the studies reported all outcomes (Broughton et al., 2006; Hobday et al., 2017; Irvine et al., 2012; Luconi et al., 2008; Rosen et al., 2002).

Study Quality

The three RCT studies (Broughton et al., 2011; Downs et al., 2006; Rosen et al., 2002), were evaluated using the CASP quality criteria for RCTs, and the single treatment group studies (non-RCTs) (7 studies) (Banks et al., 2014; Chao et al., 2016; Hobday et al., 2017; Luconi et al., 2008; Irvine et al., 2012; Pleasant et al., 2017; Ruiz et al., 2006) were evaluated using CASP quality criteria for non-RCT studies (see Figure 2 and Figure 3). The RCT studies had high quality ratings overall, and demonstrated meticulousness in reporting, including descriptions of the population of interest, and unbiased approaches to reporting of findings. However, one RCT study did not report on the blinding of participants (Broughton et al., 2011). The quality of non-RCT studies ranged from medium (in 1 study) (Banks et al.) to high range (in the remaining 5 studies). One aspect affecting most of the non-RCT studies, thus lowering their overall quality from high to medium range, was a lack of standardized scales to measure outcomes (in 5 of the non-RCT studies) (Banks et al., 2014; Hobday et al., 2017; Irvine et al., 2012; Pleasant et al., 2017; Ruiz et al., 2006;) and a tendency to use non-validated scales (in 6 studies) (Banks et al., 2014; Downs et al., 2006; Hobday et al., 2017; Luconi et al., 2008; Irvine et al., 2012; Ruiz et al., 2006). The breakdown of the average quality ratings for individual quality criteria for RCT and non-RCT studies can be found in Figures 2 and 3, respectively.

Types of Healthcare Professionals Included in Interventions

Nurses were the most common type of healthcare professionals, and were included in half of the interventions (5 studies) (Banks et al., 2014; Broughton et al., 2011; Chao et al., 2016;

Hobday, Gaugler, & Mittelman, 2017; Rosen et al., 2002; Ruiz et al., 2006). Registered nurses (RNs) received most of their training remotely (Banks et al., 2014; Broughton et al., 2011; Chao et al., 2016; Rosen et al., 2002), and licensed practical nurses (LPNs) received their training via a computer in a classroom setting (Ruiz et al., 2006). Other healthcare professionals were managers and directors of a long-term care facility (Irvine et al., 2012). Two studies included family physicians (Banks et al., 2014; Luconi, 2008). One study focused solely on physician education (Luconi, 2008), and one study included a physician in an intervention targeted to diverse health professionals (Banks et al., 2014). The remaining professions represented included recreational activity officers (Banks et al., 2014; Broughton et al., 2011), dietitians, occupational therapists, physiotherapists, speech and language pathologists, managers (Banks et al., 2014), non-direct care staff in long-term care (Irvine et al., 2012), and other formal carers of individuals with dementia, such as volunteers with some training in care provision and who were in regular contact with patients (Pleasant et al., 2017). Recruitment of participants occurred in nursing home settings (Broughton et al., 2011), long-term care settings (Irvine et al., 2012), educational settings (Rosen et al., 2002; Ruiz et al., 2006), and mixed settings including a combination of health centers and hospitals (Chao et al., 2016; Downs et al., 2006), and via public message announcements (Chao et al., 2016) and existing organization-networks, and online recruitment strategies (Banks et al., 2014; Luconi, 2008; Pleasant et al., 2017),

Learning Methods and Types of Educational Tools

The digital modes of learning frequently featured more than one medium to convey knowledge, including video, audio-narration, asynchronous computer-based modules with educational content, graphics, and some interactive content (Banks et al., 2014; Chao et al., 2016; Hobday et al., 2017; Irvine et al., 2012; Luconi, 2008; Rosen et al., 2002) (see Table 6).

Many studies included multi-feature components of learning, including videos. For example, Banks et al. (2014) used educational video resources; Hobday and colleagues (2017) used unscripted video resources that featured scenarios with real patients and interviews with experts; Irvine and colleagues (2012) used video-modeling vignettes to emphasize case scenarios and interviews with experts; and Rosen and colleagues (2002) used interactive video modules, specially designed in a news-documentary format with exercises and questions relating to the visual content.

Many of the studies also supplemented their online learning content with other mediums such as audio narration (Hobday et al., 2017; Irvine et al., 2012), online group discussion forums (Banks et al., 2014; Luconi, 2008), and quizzes with automatic feedback (Luconi, 2008). A study by Peasant and colleagues (2017), relied mostly on presenting textual information (Pleasant et al., 2017). Additional learning features were assigned readings (Banks et al., 2014), interactive text entry, graphics, case studies (Hobday et al., 2017), and email reminders (Luconi, 2008). Two studies used designated platforms to deliver educational content; for example, one study used online education available via a work-site home page (Irvine et al., 2012), another study (Ruiz et al., 20016) used computer-based learning modules, accessible only via a computer-testing laboratory of an educational institution, and another study used modules available via an online platform licensed to the institution (Luconi, 2008).

Two studies did not convey their education online; for example, Downs and colleagues (2006) used an electronic tutorial with an indexing system embedded in existing medical records software, which produced prompts and provided real-time learning about diagnosis and management of dementia. Lastly, two studies included a required in-person attendance component. Banks and colleagues (2014) featured blended learning where participants accessed,

read, and watched e-learning resources, and communicated in an online forum prior to attending five half-day lectures. In their study, Chao and colleagues (2016) included a portion of learning delivered in a classroom and a portion of learning delivered via structured internet-based learning.

Focus of Educational Content

The broad topics of education included categories such as dementia screening and assessment (Pleasant et al., 2017), clinical decision making (Downs et al., 2006), individualized care (Hobday et al., 2017; Pleasant et al., 2017; Ruiz et al., 2006), care management (Luconi, 2008; Rosen et al., 2002), enhancing skill and confidence (Irvine et al., 2012; Luconi, 2008), enhancing communication abilities (Irvine et al., 2012; Rosen et al., 2002), coping (Rosen et al., 2002), attitudes toward dementia care (Ruiz et al., 2006), vulnerability and ethical issues (Pleasant et al., 2017; Rosen et al., 2002), and end of life care and discharge (Pleasant et al., 2017). Interventions also targeted larger groups of healthcare professions with a varying skill levels, and focused on developing materials with 6th to 8th grade reading levels (Hobday et al., 2017; Irvine et al., 2012; Rosen et al., 2002).

The learning materials included content about memory profiles in dementia (Banks et al., 2014; Broughton et al., 2011; Rosen et al., 2002; Ruiz et al., 2006), clinical reasoning (Downs et al., 2006), dementia diagnosis (Luconi, 2008; Pleasant et al., 2017), patient care strategies (Broughton et al., 2011; Downs et al., 2006; Hobday et al., 2017; Irvine et al., 2012; Luconi, 2008; Pleasant et al., 2017; Rosen et al., 2002; Ruiz et al., 2006), managing behavioral and psychological aspects of dementia (Chao et al., 2016), changing attitudes toward dementia care (Ruiz et al., 2006), working with vulnerable populations (Pleasant et al., 2017; Rosen et al.,

2002), and communication strategies (Broughton et al., 2011; Chao et al., 2016; Irvine et al. , 2012; Rosen et al., 2002).

Evaluation of Digital Educational Tools

The studies generally focused on evaluating dementia knowledge (Banks et al., 2014; Hobday et al., 2017; Ruiz et al., 2006; Pleasant et al., 2017; Rosen et al., 2002) and included scales developed by study authors, some of which were validated (Hobday et al., 2017, Rosen et al., 2002, Ruiz et al., 2006). For example, Hobday and colleagues (2017), Rosen and colleagues (2002), and Ruiz and colleagues (2006) did not include scale validation, and measures used by Banks and colleagues (2014) (Approaches to Dementia Scale: ADS) and Pleasant et al. (2017) (Dementia Knowledge Questionnaire: DKQ) included scale validation (see Table 7). Studies also focused on satisfaction with care giving. For example, Broughton and colleagues (2011) used two types of scales (Positive Aspects of Care Giving Questionnaire: PAC, and Caregiver Satisfaction; both validated scales with high convergent validity and internal consistency reliability), plus patient communication skills via self-reported surveys. Chao and colleagues (2016) used four validated scales (Communication Knowledge Scale: CKS-C, Communication Skills Attitudes Scale: CSAS-C, Patients' Receptive and Expressive Ability: PREAS, and Revised memory and Behavior Problems Checklist: CSDD-C; all scales were Chinese versions), all with evidence of high reliability and validity.

Studies also measured self-efficacy and competence in care, but varied in the quality of their measurement. Banks and colleagues (2014) and Ruiz and colleagues (2006) used non-validated scales developed for the purpose of assessing their respective program materials. Similarly, Irvine and colleagues (2012) used a measure of situational self-efficacy in response to a video-situation test which was specially developed and validated for intervention purposes.

Pleasant and colleagues (2017) used a validated scale (Sense of Competence in Dementia Scale: SCIDS) to assess participant competency, and Irvine and colleagues (2012) used the video situation test with validated measures to assess attitudes toward dementia care and behavioral intentions with regards to behavior change. The study by Luconi (2008) measured only reaction to training with the Barometer scale (non-validated scale, developed to measure readiness to learn), as well as confirmation of new learned knowledge with existing knowledge using the Participant Reaction Questionnaire (PRQ-I, also not validated). Lastly, a study by Downs and colleagues (2006) measured dementia detection rates and concordance with guidelines by directly extracting tracked information from patient health records, and using coded checklists for diagnosis concordance and management concordance.

Outcomes

Study outcomes corresponded to the measures developed or chosen for specific hypothesized effects. Four studies (Downs et al., 2006; Rosen et al., 2002; Pleasant et al., 2017; Ruiz et al., 2006) evaluated dementia knowledge, and all four found significant improvement on measures of dementia knowledge (see Table 7). Other aspects of dementia knowledge that were measured included dementia care, dementia care management knowledge, and change in practice (Downs et al., 2006; Hobday et al., 2017). Hobday and colleagues (2017) found a significant difference in dementia care knowledge, while Downs and colleagues (2006) (using a checklist reflecting dementia practice) did not find a significant change in practice.

Two studies (Banks et al., 2014; Broughton et al., 2011) addressed knowledge of care strategies in their outcomes. These studies used measures such as the Approaches to Dementia Scale, Positive Aspects of Care giving, and caregiver satisfaction to measure knowledge of care, all of which indicated a significant positive change in knowledge relating to dementia care

strategies. A study by Chao and colleagues (2016) examined communication skills with validated, adapted and translated scales (adapted for Chinese speakers), all of which indicated significant findings, with the exception of a scale indicating a lack of change in communication-related attitudes (Communication Skills Attitudes Scale-Chinese Version: CSAS-C).

Four studies (Irvine et al., 2012; Banks et al., 2014; Pleasant et al., 2017; Ruiz et al., 2006), measured a change in reported self-efficacy and found significant changes. Lastly, a study by Irvine and colleagues (2012) measured change in attitudes toward dementia care and found significant results, indicating that the intervention was effective in enhancing more positive attitudes toward dementia care.

Discussion

While previous systematic reviews focused on satisfaction-based evaluations of educational interventions (Surr et al., 2017), specific work settings (Beeber et al., 2010; Kuske et al., 2007), healthcare populations (Alushi et al., 2015), communication (Eggenberger et al., 2013), approaches (Fossey et al., 2014), organizational outcomes (Elliot et al., 2012), or defined aspects/outcomes of dementia training, such as management (Brody et al., 2013), the present review focused only on digital modes of dementia education for healthcare professions which included pre- and post-intervention measures. Ten studies describing technology-based dementia education to healthcare professionals with pre- and post-education comparisons were identified. Despite a variability in educational mediums and educational delivery, and although recent research indicates that interactive components have better effects on learning receptiveness (Surr et al., 2017), all of the studies demonstrated positive changes in outcomes. Additionally, the studies featured an array of professionals, working in a wide variety of work environments, using adaptable and flexible technologically-delivered modes of education. Future technology-based

dementia educational interventions for healthcare providers would greatly benefit from the inclusion of a control group, such as in an RCT design, and the inclusion of validated scales. Such additions could improve the quality and generalizability of study findings.

While the risk of bias assessment could not be completed due to a lack of a control condition in most studies, the CASP quality rating of literature indicated that the authors were measuring the intended constructs in their interventions. A meta-analysis of the findings was also not possible due to the heterogeneity in measurement tools and outcomes. Nevertheless, all studies found at least some positive impact of the interventions on outcomes, regardless of the mode of intervention, materials used in the intervention, or validation of scales, indicating that technology-based dementia education did have a positive impact on learning for healthcare providers.

Limitations/Strengths/Recommendations

A limitation of this review is that it focused only on studies available in English. Due to a wide variety of measures/outcomes, a meta-analysis also was not possible, and due to the same heterogeneity, most studies had an unknown risk of bias. Studies with this type of intervention, targeting healthcare providers that feature a control group or an RCT design, could improve the ability to perform bias ratings, and thus provide a better evaluation of study quality. Additional benefits of an RCT design are a greater confidence in the results, and an assurance that a meaningful change occurred.

Due to the heterogeneous nature of interventions and desired outcomes, it was difficult to distinguish which types of approaches were more efficacious than others. However, it is noteworthy that all of the interventions, regardless of their design, duration, type of digital tool, or content of materials, noted a positive change in outcomes. Videos featuring modeling, case-

based scenarios, and interviews with experts were deemed beneficial. Other features deemed useful by participants were email reminders to complete modules, a calendar function, and available technical support (Luconi, 2008). Future interventions should focus on including a variety of interactive, textual and graphic materials. Interventions designed to retain attention and keep participants stimulated are also likely to ensure continued engagement. Periodic testing of the learned materials may also be useful for rehearsing and encoding learned information, and can favorably affect not only the intended outcomes, but also long-term knowledge retention (Karpicke & Smith, 2012).

When developing an intervention for a specific healthcare population, it may be advantageous for researchers to consider the level of knowledge, skill, or previous training of such populations. By building on existing knowledge, skills, and needs of healthcare practitioners, one can ensure that an intervention will ameliorate knowledge gaps and increase receptiveness. Additionally, the choice of content delivery may depend on intended outcomes. For example, if a successful outcome is improving the knowledge of a memory profile in dementia, then the materials in the intervention should focus on conveying and assessing such knowledge. Another useful feature of a technology-based, asynchronous dementia education is content development, based on healthcare provider input, need, or skill-level as indicated by performance on a pre-intervention measure. As noted in previous research by Degryse and colleagues (2009) and Scott and colleagues (2015), interventions that are suited to the unique needs of specific healthcare practitioner groups are more likely to have a positive effect on knowledge acquisition and behavior change.

All of the studies in the review used scales to measure outcomes; however, some of the studies used newly developed scales (Hobday et al., 2017; Irvine et al., 2012; Rosen et al., 2002),

and not all of the scales were validated (Hobday et al., 2017; Rosen et al., 2002; Ruiz et al., 2006). Researchers recommend using validated scales to help ensure that any obtained differences are not present due to measurement bias (Arribas-Marín, Hernández-Franco, & Plumed-Moreno, 2017; Wood, Garb, Lilienfeld, & Nezworski, 2002). Nevertheless, many studies did not employ this approach. Therefore, increased confidence in the intervention outcomes could be obtained with the use of validated scales. Last but not least, future researchers may consider administering education based on a learning model or a theory. While this approach does not guarantee significant or observable changes, a theory will help to determine the delivery of information and potential outcomes, and can assist in determining appropriate measures.

Conclusion

The review uncovered compelling confirmation of effectiveness of various digitally-conveyed dementia education modes for healthcare providers. The review also revealed a variety of interventions, including computer-based and video-based learning, targeting a large array of health professionals, featuring materials developed to suit a broad range of skill levels and knowledge. The most common type of intervention occurred via computer, and through the completion of learning modules. The content of interventions focused on a variety of topics including dementia diagnosis (Downs et al., 2006; Pleasant et al., 2017), issues related to care (Hobday et al., 2017; Pleasant et al., 2017; Ruiz et al., 2006), and issues related to management (Luconi, 2008; Rosen et al., 2002; Irvine et al., 2012; Rosen et al., 2002).

While there was little consistency in use of validated measures to assess intended outcomes, and while in some cases development of new measures was imperative, validation prior to measurement would have assisted in ensuring that the intended construct(s) were being

measured. The duration of an intervention did not appear to affect outcomes as long as the intended information was conveyed (Banks et al., 2014; Broughton et al., 2011; Chao et al., 2016; Downs et al., 2006; Hobday et al., 2017; Irvine et al., 2012; Luconi et al., 2008; Pleasant et al., 2017; Rosen et al., 2002; Ruiz et al., 2006). Lastly, regardless of the intervention duration, all of the studies found a significant positive change in their outcomes, with an exception of two outcomes: change in participants' practice (Downs et al., 2006), and attitudes toward communication skills (Chao et al., 2016). Past research shows that changing practice is difficult (Berner et al., 2003; Sivananthan et al., 2013), and change in attitudes may require additional time or ongoing support and consultation to achieve (Hayes, 2003). Taking all of the evidence in consideration, the variety of educational material presentation, together with interactive nature of materials, was generally advantageous for learning and continued participation of healthcare professionals.

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Table 1. Adapted quality rating criteria for non-randomized controlled trial studies

Quality criteria	Specific questions relating to rating considerations	Rating
1. Are the research aims and questions/hypotheses clearly stated?	• Do(es) the author(s) clearly state what they plan to research?	0 = no; 1 = partially; 2 = yes
2. Are ethical issues addressed?	• Do(es) the author(s) state that ethical approval was sought?	0 = no; 1 = partially; 2 = yes
3. Are the methodology/study design appropriate to the research question and rationale for choice evident?	• Do(es) the author state what research methodology they have chosen? • Is the chosen methodology appropriate to research question? • Does the author(s) justify the research design used?	0 = no; 1 = partially but with weaknesses/missing info; 2 = yes
4. Are the sample size, selection and description appropriate?	• Do(es) the author(s) clearly state how the study sample size was identified? • Do(es) the sample size appear to be large enough? • Do(es) the author adequately describe the sample (e.g., gender, age, relationship to care receiver) so that the reader can determine transferability of findings?	0 = no; 1 = partially but with weaknesses/missing info; 2 = yes
5. Are the method(s) of data collection appropriate, reliable, and valid?	• Do(es) the author(s) justify that the measure is suitable for this population? • Do(es) the author(s) use measures that measure the desired constructs? • Do(es) the author(s) indicate that the measures have good psychometric properties? • Do(es) the author(s) indicate that the measures used have demonstrated validity?	0 = no; 1 = partially but with weaknesses/missing info; 2 = yes
6. Are the method(s) of data analysis reliable and valid?	• Do(es) the author(s) state which statistic tests were used? • Do(es) the author(s) use statistical tests that appear to be appropriate to the nature of the data collected? • Were statistical tests appropriate to research question? • Do(es) the author(s) provide evidence of statistical findings or state levels of significance?	0 = no; 1 = partially but with weaknesses/missing info; 2 = yes

7. Are the findings and discussion clearly stated and appropriate?	• Do(es) the author(s) present the statistical data in a clear manner, or clearly differentiate between significant or non-significant findings?	0 = no; 1 = partially; 2 = yes
8. Can the results be applied to the local population?	• How similar are the participants to the population to which the recommendations are applied?	0 = no; 1 = partially; 2 = yes
9. Were all clinically important outcomes considered?	• Was there other information about the outcomes which was missed?	0 = no; 1 = partially; 2 = yes Range: 0-18

Note: 1-6 = low range, 7-12 = medium range, 13-18 = high range

Table 2. Adapted quality rating criteria for randomized controlled trial studies

Quality criteria	Specific questions relating to rating considerations	Rating
1. Did the research question clearly address a focused issue?	• Was the research question focused on the target population, and the intervention? • Were outcomes in research considered?	0 = no; 1 = partially; 2 = yes
2. Was the assignment of participants randomized to the intervention or the control group?	• How was randomization achieved? • Was randomization concealed from researcher or participants?	0 = no; 1 = partially; 2 = yes
3. Were all of the participants properly accounted for at the conclusion of the intervention?	• Were the participants analyzed in groups to which they were randomized?	0 = no; 1 = partially; 2 = yes
4. Were participants, and care recipients blind to whether they were in the intervention or the control group?	• Consider reporting of participant blinding to intervention/control, and blinding of researcher(s) to condition in assessment of outcomes.	0 = no; 1 = partially; 2 = yes
5. Were the intervention and control groups similar at the start of the study?	• Were the intervention and control groups similar in terms of their age, sex, social class...etc?	0 = no; 1 = partially; 2 = yes
6. Aside from the intervention group, where the intervention and	• Here also consider duration of intervention or placebo.	0 = no; 1 = partially; 2 = yes

control groups treated equally?		
7. How large was the treatment effect?	• Was/were the primary outcome(s) clearly stated? • What were the results for each outcome?	0 = no; 1 = partially; 2 = yes
8. How precise was the estimate of the treatment effect?	• What were the confidence limits?	0 = no; 1 = partially; 2 = yes
9. Can the results be applied to the local population?	• How similar were the participants to the population to which the recommendations were applied?	0 = no; 1 = partially; 2 = yes
10. Were all clinically important outcomes considered?	• Was there other information about the outcomes that was missed?	0 = no; 1 = partially; 2 = yes
11. Are benefits worth the harms and costs?	• Here consider possibility of harm in the control condition, if education piece was missed.	0 = no; 1 = partially; 2 = yes Range: 0-21

Note: 1-7 = low range, 7-15 = medium range, 16-21 = high range

Table 3. Studies included in the review ($N = 10$)

Author, year	Theoretical model	Design, sample size, attrition, female (%)	Duration of type of intervention	Follow-up	Outcome scales
Chao, 2016	Adult Learning Theory	QEWPP, *n* = 105, *n* = 2, Female: 100%	16 weeks; 4 learning modules: modules 1 and 2, 4 hour classroom lectures and workshop, modules 3 and 4 online modules	Week 4, week 16	CKS-C, CSAS-C, PREAS
Hobday, 2017	The CARES™ Dementia-Friendly Hospital Program Learning Principles	WSPP, *n* = 25, *n* = NA, Female: 96%	7 to 10 days; 4 online learning modules, 15-20 minutes in duration	Baseline, 10 days	Dementia Knowledge Scale
Irvine, 2012	Social Cognitive Theory, Expanded Theory of Reasoned Action	WSPP, *n* = 57, *n* = 11, Female: 85.9%	2 hours total, self-paced; 5 modules available via work web-site	Baseline, 14 days, 30 days	Video Situation Test: attitudes, self-efficacy, behavioral intentions
Ruiz, 2006	No model	WSPP, *n* = 38, *n* = NA, Female: 89%	2 days, 7 modules, each 20-30 minutes, administered via CD-Rom in computer lab	Baseline, post intervention	Dementia knowledge, Self-perceived efficacy
Banks, 2014	No model	PP, *n* = 113, *n* = NA, Female: NA	5 months, online learning modules completed prior to study/community setting days	Baseline, post intervention	ADS, Self-efficacy
Pleasant, 2017	CARES™ Dementia Basics Program Principles	PP, *n* = 51, *n* = 11, Female: 88%	2 weeks, 4 online learning modules,	Baseline, post	DKQ, SCIDS

			40 minutes in duration	intervention, 30 days	
Luconi, 2008	Cognitive Constructivism Theory, Socio-Constructivism, Four-Stage Theory of Physician's Learning, Clinical Reasoning Model	CS, *n* = 8, *n* = NA, Female: 38%	14 hours, over 9 months, 7 online modules, each 3 hours in duration	Baseline, 6 month	PRQ, Barometer
Broughton, 2011	No model	RCT, *n* = 34 (training group), *n* = 15 (control group), *n* = 3, Female: 86.5%	Training DVD, 50 minutes	Baseline, post intervention, 3 months	PAC, Caregiver Satisfaction Questionnaire
Downs, 2006	No model	RCT, *n* = 9 (practice-based workshop), *n* = 8 (electronic tutorial), *n* = 8 (decision-based software), *n* = 10 (control), *n* = 1, Female: 79.4%	12 months, electronic tutorial available on a CD-Rom, integrated in electronic patient files	Baseline, post intervention	Dementia diagnosis concordance, dementia management concordance
Rosen, 2002	No model	RCT, *n* = 103 (Lecture site, attrition = 15%), *n* = 70 (Computer-based training, attrition = 26%), *n* = 106 (control, attrition = 26%), Female: NA	6 months, 12 computer-based interactive video training modules	Baseline, post intervention	Dementia knowledge

Note: RCT = randomized controlled trial, QEWPP = quasi-experimental with pre- and post- measures, WSPP = within subjects with pre- and post- measures, PP = pre- and post- measures, CS = controlled case study, NA = not available, CKS-C = Communication

Knowledge Scale – Chinese version, CSAS-C = Skills and Attitudes Scale- Chinese version, PREAS = Patient's Receptive and Expressive Ability Scale, ADS = Approaches to Dementia Scale, CCS = Communication Competency Scale, CPS = Communication Performance Scale, DKQ = Dementia Knowledge Questionnaire, SCIDCS = Sense of Competence in Dementia Care- Staff Scale, PRQ-I = Participant Reaction Questionnaire, PAC = Positive Aspects of Care giving.

Table 4. Characteristics of included studies ($N = 10$)

Description	N (%)
Country of study	
United States	5 (50)
United Kingdom	1 (10)
Canada	1 (10)
Australia	1 (10)
Scotland	1 (10)
Taiwan	1 (10)
Health professionals[a]	
Nurses	5 (50)
Licensed practical nurses	1 (10)
Certified nursing assistants	2 (20)
Non-direct care staff	1 (10)
Family physicians	2 (20)
Recreational activity officers	2 (20)
Dieticians	1 (10)
Occupational therapists	1 (10)
Physiotherapists	1 (10)
Speech and Language Pathologists	1 (10)
Managers	1 (10)
Volunteers	1 (10)
Allied health professionals	1 (10)
Setting	
Long-term care	2 (20)
Nursing home	1 (10)
General practice	2 (20)
Secondary education/professional development	2 (20)
Primary care	1 (10)
Acute care	1 (10)
Hospital	1 (10)
Location	
Urban	0 (0)
Rural	1(10)
Unknown	9 (90)
Study Quality	
High	8 (80)
Medium	2 (20)
Low	0 (0)

[a]Number of health professionals is greater, since some of the studies used multiple types of health professionals in their interventions.

Table 5. Risk of bias assessment ($N = 10$)

Author, year	Type of study	Random sequence generation	Allocation concealment	Blinding of participants	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Chao, 2016	Pre/Post	?	?	?	?	-	-
Hobday, 2017	Pre/Post	?	?	?	?	+	-
Irvine, 2012	Pre/Post	?	?	?	?	+	-
Ruiz, 2006	Pre/Post	?	?	?	?	-	-
Banks, 2014	Pre/Post	?	?	?	?	-	-
Pleasant, 2017	Pre/Post	?	?	?	?	-	-
Luconi, 2008	Pre/Post	?	?	?	?	+	-
Broughton, 2011	RCT	?	-	-	?	+	-
Downs, 2006	RCT	-	-	-	?	-	-
Rosen, 2002	RCT	?	?	?	?	+	-

Note: Pre/Post = study with a single group, utilizing a measure of effect, pre and post intervention, RCT = study utilizing randomized controlled trial in design, ? =unknown risk bias, - = low risk bias, + = high risk bias

Table 6. Teaching and learning approaches ($N = 10$)

Teaching/learning approaches	*N* (%)
Computer-based learning	100 (100)
Learning via alternate mediums	
CD-Rom	2 (20)
DVD	1 (10)
Learning with an online component	7 (70)
Learning with an online and a face-to-face component	2 (20)
Access via a moderated platform	2 (20)
Video-based learning	
Video scenarios	2 (20)
Video modeling vignettes	4 (40)
Videos featuring unscripted interactions (patients, staff, caregivers)	1 (10)
Videos featuring expert commentary	2 (20)
Case studies	2 (20)
Interviews with staff members	1 (10)
Audio-narration	2 (20)
Interactive text entry	1 (10)
Discussion board	2 (20)
Moderated discussion board	1 (10)
Quizzes with automatic feedback	1 (10)
Course email/calendar	1 (10)
Technical assistance help function	1 (10)

Table 7. Classification of statistically significant outcomes by scales

Outcome, scales	Dementia education available online				Dementia education available via alternate mode(s)			Dementia education with an applied component or requiring in-person presence		
	Rosen, 2002	Luconi, 2008	Pleasant, 2017	Hobday, 2017	Downs, 2006	Broughton, 2011	Irvine, 2012	Banks, 2014	Ruiz, 2006	Chao, 2016
Dementia general knowledge										
Dementia diagnostic knowledge	+[b]								+[b]	
DKQ			+							
Diagnosis concordance					+[b]					
Dementia care/management knowledge										
Management concordance					0[b]					
Dementia Care Knowledge Scale				+[b]						
Readiness to change										
Video Situation Test- Behavioral Intentions							+[b]			
Reaction to training										
PRQ-I		+[b]								
Barometer-Readiness to Learn		+[b]								
Care strategies										
ADS								+		

PAC		+			
Caregiver Satisfaction		+			
Communication skills					
CKS-C					+
CSAS-C					0
PREAS					+
CSDD-C					+
Self-efficacy and competence					
Video Situation Test-Self-efficacy			+		
Self-efficacy				+[b]	
SCIDS	+				
Self-Perceived Efficacy				+[b]	
Attitudes					
Video Situation Test- Attitudes			+		

Note: Participant Reaction Questionnaire = PRQ-I; Dementia Knowledge Questionnaire = DKQ; Approaches to Dementia Scale = ADS; Positive Aspects of Care Giving Questionnaire = PAC; Communication Knowledge Scale-Chinese Version = CKS-C; Communication Skills Attitudes Scale-Chinese Version = CSAS-C; Patient's Receptive and Expressive Ability = PREAS; Revised Memory and Behavior Problems Checklist-Chinese Version = CSDD-C; Sense of Competence in Dementia Care Stall Scale = SCIDS; +: statistically significant effect of the intervention on measured outcome, 0: not statistically significant effect, [b]: validation process of the measure was not reported.

Appendix

PsycINFO MeSH terms and keywords logic grid

caregivers OR (care provid$3 OR care partner OR family care$6 OR family care partner OR family care provider OR familial care OR family carer OR informal carer OR primary caregiv$2 OR child caregiv$ OR spouse caregiv$ OR informal caregiver OR informal caregiv$).mp	dementia OR Alzheimer's disease OR Parkinson's disease OR vascular dementia OR dementia with Lewy bodies OR semantic dementia OR neurodegenerative diseases OR cognitive impairment OR neurodegeneration OR (frontotemporal dementia OR early onset dementia OR young onset dementia OR late onset dementia OR mild cognitive impairment OR late elderly dementia).mp	online education OR computer assisted instruction OR distance education OR internet OR computer applications OR computer searching OR computer training OR technology OR machine learning OR virtual classrooms OR multimedia OR websites OR electronic learning OR mobile devices OR telemedicine OR teleconferencing OR videotape instruction OR telecommunications media OR telephone systems OR (online learning OR online training OR online program OR online tool OR online resources OR computer-based OR computerized OR asynchronous OR portal OR learning application OR videoconferencing OR telephone-based OR telephone-delivered).mp